(19) Japanese Patent Office (JP) (11) Unexamined Patent Application Publication

(12) **Unexamined Patent Gazette** (A) S60–130203

(51) Int. Cl.[4] Identification symbols Internal file number (43) Publication date 11 July 1985
H 03 D 7/00 7420–5J

Request for examination: Not filed Number of inventions: 1 (3 pages total)

(54) Title of invention Frequency converter

(21) Application S58–239242

(22) Filing date 19 December 1983

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Specification

1. Title of invention
   Frequency converter
2. Scope of patent claims

A frequency converter comprising a first filter circuit unit which restricts the frequency band of an input signal; a sampling circuit unit which samples signals passing through said first filter with a specific sampling period; and a second filter circuit unit which selects a frequency band shifted by an integral multiple of said sampling period from said input signal frequency out of the time-discrete signals generated by said sampling circuit unit.

3. Detailed description of the invention

Field of industrial application

The present invention relates to frequency converters for performing frequency conversion required for modulation, demodulation and the like.

Constitution and problems of the prior art

Conventional frequency converters are fundamentally constituted using a multiplier circuit. Namely, in a conventional frequency converter, if the input signal Vi is assumed to be

[see source for formula] ... ... (1)

(where Ei: amplitude of input signal; ω_i: angular frequency of input signal; t: time) and the locally generated signal V_l introduced for the multiplication is

[see source for formula] ... ... (2)

(where E_l: amplitude of locally generated signal; ω_l: angular frequency of said signal; t: time), then the signal V_o obtained by multiplication thereof will be

[see source for formula] ... ... (3)

Here, frequency conversion has been performed by extracting the $(\omega_i + \omega_l)$ or $(\omega_i - \omega_l)$ frequency component from said signal V_o by means of a band pass filter circuit.

However, the actual circuits for this all have an analog circuit constitution, which tends to lead to larger device size and complex adjustment functions, and there have been many problems with respect to miniaturizing devices and making them adjustment-free, and in dealing with chronological changes.

Purpose of the invention

The present invention provides a frequency converter which is not based upon a multiplier circuit constitution but is rather based on a sampling system.

Constitution of the invention

The present invention, in summary, is a frequency converter comprising a first filter circuit unit which restricts the frequency band of an input signal; a sampling circuit unit which samples signals passing through said first filter with a specific sampling period; and a second filter circuit unit which selects a frequency band shifted by an integral multiple of said sampling period from said input signal frequency out of the time-discrete signals generated by said sampling circuit unit, whereby arbitrary frequency conversion is carried out by means of a relatively simple circuit configuration, and miniaturization and stabilization of devices is achieved.

Description of embodiments

Figure 1 is a basic diagram of an embodiment of the present invention, which comprises an input terminal 1, a first filter circuit unit 2, a sampling circuit unit 3, a second filter circuit unit 4 and an output terminal 5.

In the configuration of Figure 1, an input signal $f(t)$ is applied to the input terminal 1, restricted to a desired frequency band at the first filter circuit unit 2, and sampled at the sampling circuit unit 3. The time-discrete signal f_s generated by means of this sampling can be expressed as

[see source for formula] ... ... (4)

(where T: sampling time; $\delta(t)$: delta function; n: integer).

Furthermore, after performing a Fourier transform on the time-discrete signal $f_s(t)$ indicated in formula 4, the resulting transformed signal $F_s(\omega)$ can be represented by

[see source for formula] ... ... (6)

(where $F(\omega)$: Fourier-transformed input signal $f(t)$; ω_o: angular frequency expressed by $2\pi/T$). Therefore, by introducing the time-discrete signal $f_s(t)$ generated at the sampling circuit unit 3 into a suitable second filter circuit unit 4, i.e. into a filter circuit capable of selecting the desired Fourier-transformed signal $F(\omega - n\omega_o)$ out of the Fourier-transformed signal represented by formula (6), and extracting the output thereof from the output terminal 5, frequency conversion can be performed.

Figure 2 is a more detailed diagram of an embodiment of the present invention, wherein, in addition to the constitution of Figure 1, an input signal amplification circuit unit 6 which amplifies the input signal $f(t)$ to a suitable level; a control signal input terminal 7 to the sampling circuit unit 3; and an output signal amplification circuit unit 8 are provided.

Figure 3 is a basic explanatory drawing showing the operation in the angular frequency domain. To describe the operation of the embodiment configuration shown in Figure 2 while referring to this drawing, an input signal $f(t)$ which enters the input terminal 1 is amplified to a suitable level at the input signal amplification circuit unit 6, and out of this signal, the signal with an angular frequency ω_p designated by symbol 9 in Figure 3 is selected by means of a band pass filter circuit unit 2 which passes the desired frequency band. Next, the result is introduced into the sampling circuit unit 3, where sampling of an arbitrary angular frequency ω_s designated by the symbol 10 in Figure 3 is performed by means of control signals applied to the control terminal 8. The signal generated at this sampling circuit unit 3 comprises a Fourier-transformed signal represented by formula (5), out of which a low frequency band output signal with an angular frequency $(\omega_p - \omega_s)$ designated by the symbol 11 in Figure 3 is obtained by means of a suitable low pass filter circuit unit 4. Then, finally, that signal is amplified to an adequate level by means of the output signal amplification circuit unit 8, and the appropriate signal is extracted from the output terminal 6.

In the frequency converter of the present invention, by arbitrarily controlling the sampling time T, it is possible to perform frequency conversion of an input signal to an arbitrary frequency band.

Effect of the invention

According to the present invention, it is possible to perform frequency conversion of an input signal to a signal of an arbitrary frequency band by means of a first filter circuit unit which passes only signals of a specific frequency band, a sampling circuit unit, and a second filter circuit unit which selectively extracts signals generated in the sampling circuit unit. Furthermore, with the frequency converter of the present invention, as can be seen from the fact that it can be implemented without using a multiplier

circuit, device miniaturization is easy, and furthermore, by quantizing the amplitude, it can be broadly applied to digital signal processors as well, and allows high signal transmission system reliability to be implemented.

4. Brief description of the drawings

Figure 1 is a basic diagram of an embodiment of the present invention; Figure 2 is a more detailed diagram of an embodiment of the present invention; Figure 3 is a general explanatory drawing of the angular frequency domain of the same embodiment.

1 ··· ··· input terminal; 2 ··· ··· band pass filter circuit unit; 3 ··· ··· sampling circuit unit; 4 ··· ··· low pass filter circuit unit; 5 ··· ··· output terminal; 6 ··· ··· input signal amplification circuit unit; 7 ··· ··· sampling circuit control terminal; 8 ··· ··· output signal amplification circuit unit.

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[see source for drawings]

Figure 1

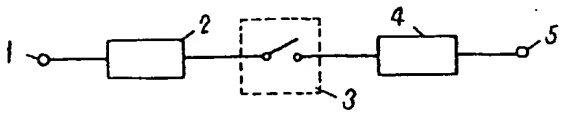

Figure 2

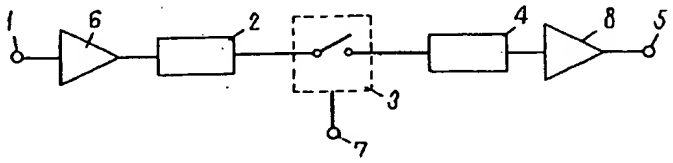

Figure 3